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A COMPARISON OF EPIPHYTIC DIATOM ASSEMBLAGES ATTACHED TO FILAMENTOUS ALGAE IN LOTIC FRESHWATER HABITATS OF CHILE*

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ABSTRACT

Lotic freshwater diatoms populations growing on filamentous algae, e.g. *Cladophora glomerata* (L.) Kuetz., *Rhizoclonium hieroglyphicum* (Kuetz.) Stockm., *Oedogonium spp., Hydrodictyon reticulatum* (L.) Lagerh. and *Vaucheria* sp. are examined.

A total of 55 taxa from 18 genera of diatoms were determined. Information on abundance and species composition of the attached diatom assemblages and specifity between host-algae and epiphytes is also presented.

KEY WORDS: Diatoms, epiphyte, taxonomy, lotic freshwaters, Chile.

RESUMEN

En este trabajo se estudió poblaciones de diatomeas de hábitats dulceacuícolas lóticos, que crecen como epífitas en algas filamentosas, tales como *Cladophora glomerata* (L.) Kuetz., *Rhizoclonium hierogliphycum* (Kuetz.) Stockm., *Oedogonium* spp., *Hydrodictyon reticulatum* (L.) Lagerh. y *Vaucheria* sp.

Se determinó un total de 55 taxa pertenecientes a 18 géneros. Se entrega información sobre la abundancia y composición de especies y sobre especificidad entre alga hospedero y diatomeas epífitas.

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INTRODUCTION

Benthic algal communities are important primary producers particularly in lotic habitats and shallow lakes. Interest on these algal communities, i.e., periphyton, epiphyton, epilithon, methaphyton, etc., from aquatic ecosystems is increasing. Much has been done on taxonomy and ecology of freshwater phytoplankton, but far less is known about the taxonomy and ecology of algal communities living attached to submerged substrates (artificial and natural) and those free-living on mud or sediment surfaces (Round, 1964; Wetzel, 1975).

Most of the research on attached algae has dealt with aquatic macrophyta or using artificial surfaces, (Castenholz, 1961; Foerster and Schlichting 1965; Tippet, 1970; Brown, 1976; Eminson, 1978; Cattaneo and Kalff, 1978, 1979; Tuchman and Blinn, 1979; Paul **et al.**, 1977). However, relatively few studies have been made on micro-flora growing on freshwater filamentous algae.

It is unquestionable, at the light field data, that there is a very little specificity in nature with regard to epiphytes and substrate. The attachment of epiphytic algae is in part related to the structure layer of the vegetable host. It is also important to point out that the mode of cell division, i.e., apical or intercalar cell division, play a role, particularly in the distribution of the epiphytes on the host (Godward, 1937).

Data obtained from several studies on epiphytic populations from different macrophytes have indicated that epiphytes are not specifically linked with particular host species. Moss (1976) and Eminson and Moss (1980) reported that the nature of the substrate has a little effect upon the epiphyte populations; this seems to be largely determined by physical and chemical characteristics of the water and not by the substrate to which they are attached.

Hutchinson (1975) emphasized that "it is reasonable to suppose that the main factors involved in regulating colonization by epiphytes are hydrographic, notably water level and water movements, optical and chemical".

Some filamentous algae have a large amount of epiphytes (e.g., *Cladophora* spp.) but some other have few epiphytes such as Zygnematales or Conjugales (Chlorophyceae). Emison and Moss (1980) showed that the Zygnematales have evolved anti-epiphyton mechanisms, (e.g., slimy surfaces) that discourage attachment.

This paper examines the diatoms populations growing on the following filamentous algae: *Cladophora glomerata* (L). Kuetz., *Rhizoclonium hieroglyphicum* (Kuetz.) Stockm., *Oedogonium* spp., *Hydrodictyon reticulatum* (L.) Lagerh., and *Vaucheria* sp.

Nothing is known about benthic algae of the Chilean freshwater bodies (Parra and González, 1977). There is only one study, on the matter but restricted to the taxonomy and ecology of a population of *Stylococcus aureus* Chodat growing as epiphytes on several freshwater phytoplankters (Parra, 1975).

The purpose of this work is to obtain preliminary information about (1) the abundance and species composition of the attached diatom assemblages and (2) specificity between host and epiphytes.

MATERIAL AND METHODS

The material examined was collected at the following localities:

N° 1412 Estero Conchalí	31°52'S	71°29'W; (4.10.1980):	*Cladophora*
N° 1413 Estero Conchalí	31°52'S	71°29'W; (4.10.1980):	*Vaucheria*
N° 1416 Estero Millahue	31°37'S	71°32'W; (4.10.1980):	*Cladophora*
N° 1417 Estero Millahue	31°37'S	71°32'W; (4.10.1980):	*Cladophora*
N° 1418 Río Choapa	31°35'S	71°33'W; (4.10.1980):	*Cladophora*
N° 1419 Río Choapa	31°35'S	71°33'W; (4.10.1980):	*Cladophora*

N° 1423 Riachuelo	29°07'S	70°55'W; (4.10.1980)	: *Oedogonium*
N° 1425 Estero cerca Río Limarí	30°38'S	71°33'W; (4.10.1980)	: *Rhizoclonium*
N° 1451 Río Limarí	30°41'S	71°32'W; (8.10.1980)	: *Vaucheria*
N° 1459 Estero Pullalli	32°26'S	71°19'W; (8.10.1980)	: *Oedogonium*
N° 1632 Río Angostura	33°52'S	70°45'W; (2.12.1980)	: *Cladophora, Hydrodictyon*
N° 1637 Río Peuco	33°57'S	70°43'W; (2.12.1980)	: *Cladophora*
N° 1643 Estero Tronco	33°58'S	70°44'W; (2.12.1980)	: *Oedogonium*
N° 1647 Estero Rigoleno	34°29'S	70°54'W; (3.12.1980)	: *Oedogonium*
N° 1650 Estero Rigoleno	34°29'S	70°54'W; (3.12.1980)	: *Cladophora*
N° 1667 Río Guaiquillo	36°05'S	71°48'W; (3.12.1980)	: *Cladophora, Hydrodictyon*
N° 1670 Río Lontué	35°03'S	71°15'W; (3.12.1980)	: *Cladophora*

The samples were collected by means of a glass container and then preserved in 4% formalin. In order to select algae filaments with attached algae microflora, the samples were examined in wet mounts at a magnification of 400-800 x.

The preserved and isolated filaments of each genera with their attached algal flora were first studied by light microscopy, and then, its content was submited to the process of oxidation. In order to remove non-epiphytic living material and particles, the filaments were also suspended in distilled water, washed and shaken up several times. After washing, the filaments were included in conc. HCl to obtain frustules separated from host filaments.

Diatom slides were prepared by a standard oxidation method (Hasle and Fryxell 1970) and examined with a light microscope (LM) Zeiss WL research microscope equipped with phase and Nomarski optics and photomicrographic equipment.

Cleaned frustules diatoms were air-dried on coverslips and mounted in Hyrax for light microscope observation or mounted on an aluminium stub with a silver conducting paint, gold coated and viewed with a scanning electron microscope (SEM). Cleaned frustules were also placed on formvar coated grids for viewing with the transmission electron microscope (TEM).

Specimens were examined with a Philips EM 200 transmission electron microscope (TEM) and an Autoscan-Etec U-1 scanning electron microscope (SEM) (Laboratorio de Microscopía Electrónica, Universidad de Concepión). The gold coater was made with an Edwards S-150 coater.

All material examined such as Hyrax slides, cleaned material, SEM stubs, and TEM grids are housed at Ficoteca-CONC collection, University of Concepción.

Descriptions of the Hosts

Cladophora have branched filaments, with cylindrical cells, usually sessiles and attached to the substrate; the cells present a non-muscilaginous stratified rough walls; the whole thallus commonly becomes coated with epiphytes (Figs. 175-182). *Rhizoclonium* have a non or very scarcy branching filaments with cylindrical cells; the cells have a stratified rough wall, similar to that of *Cladophora*, and its cell division is mostly intercalary. *Oedogonium* present unbranched filaments with cylindrical cells, generally free floating in the mature condition. The cell wall is usually not conspicuosly thickened, seems to be homogeneous, and with a scanty formation of muscilage; cell division is either terminal or intercalar. The production of this thin and muscilaginous layer and the concomitant intercalary cell division would be the factors that discourage the attachment of the epiphytes flora on *Oedogonium*. *Hydrodictyon* have a free-floating coenobium with cylindrical cells to form a meshwork in which most of the interspaces are bounded by five or six cells. *Vaucheria* shows an unseptable tu-

bular coenocyte with a very sparce or fairly abundant branching, apical growth and a relatively thin cell wall.

TAXONOMIC PART

The supra-species taxonomic entities are arranged in accordance to Simonsen's system (1979). The diatom species within the genera are arranged alphabetically.

CLASS *BACILLARIOPHYCEAE*
ORDER *PENNALES*
SUBORDER *ARAPHIDINAE*
Family *DIATOMACEAE*

Genus ***Ceratoneis*** Grun.

Ceratoneis arcus Ehr. var. ***arcus*** (Figs. 1,2)

Length 40-65 µm; width 6-7 µm; striae 13-14 in 10 µm at the center to 16-18 in 10 µm at the ends of the valve.

Epiphytic on *Cladophora* and *Oedogonium*.

Genus ***Diatoma*** Bory

Diatoma tenue Ag. var. ***tenue*** (Figs. 3,4)

Length 16-25 µm; width 3.5-5 µm; costae 5-9 in 10 µm; striae 18-22 in 10 µm.

Epiphytic on *Cladophora*, *Oedogonium* and *Vaucheria*.

Genus ***Fragilaria*** Lyngbye

Fragilaria brevistriata Grun. var. ***brevistriata*** (Figs. 5,6)

Length 17-20 µm; width 4.5-5 µm; striae 13-14 in 10 µm.

Epiphytic on *Cladophora*

Fragilaria construens (Ehr.) Grun. var. ***venter*** (Ehr.) Grun (Fig. 7)

Length 5-6 µm; width 4 µm; striae 10 in 10 µm.

Epiphytic on *Cladophora*.

Fragilaria pinnata Ehr. var. ***pinnata*** (Figs. 8,9)

Length 10-11 µm; width 4-5 µm; striae 12-13 in 10 µm.

Epiphytic on *Cladophora*.

Fragilaria vaucheriae (Kuetz.) Peters. var. ***vaucheriae*** (Figs. 10-14)

Length 16-39 µm; width 3-5 µm; striae 12-16 in 10 µm.

Epiphytic on *Cladophora*, *Oedogonium* and *Vaucheria*.

Genus ***Synedra*** Ehr.

Synedra acus Kuetz. var. ***acus*** (Fig. 15)

Length 90-120 µm; width 5-6 µm; striae 12-14 in 10 µm.

Epiphytic on *Cladophora*.

Synedra fasciculata (Ag.) Kuetz. var. ***fasciculata*** (Figs. 16,17)

Length 120-130 µm; width 4-5 µm; striae 12-13 in 10 µm.

Epiphytic on *Cladophora*, *Rhizoclonium* and *Vaucheria*.

Synedra pulchella Ralfs ex Kuetz. var. ***pulchella*** (Fig. 18)

Length 85-115 µm; width 5-6 µm; striae 12-16 in 10 µm.

Epiphytic on *Cladophora*.

Synedra rumpens Kuetz. var ***familiaris*** (Kuetz.) Hust. (Figs. 19,20)

Length 35-51 µm; width 3-4 µm; striae 16-19 in 10 µm.

Epiphytic on *Cladophora* and *Oedogonium*.

Synedra ulna (Nitz.) Ehr. var. ***ulna*** (Figs. 21-26)

Length 120-270 µm; width 7-8 µm; striae 9-10 in 10 µm.

Epiphytic on *Cladophora*, *Oedogonium*, *Hydrodictyon* and *Vaucheria*.

Family *ACHNANTHACEAE*

Genus ***Achnanthes*** Bory

Achnanthes hungarica (Grun.) Grun. var. ***hungarica*** (Figs. 27-30)

Length 16-22 µm; width 7-7.5 µm; striae 16-20 in 10 µm on both valves.

Epiphytic on *Cladophora* and *Vaucheria*.

Achnanthes lanceolata (Bréb.) Grun. var. ***lanceolata*** (Figs. 31-36)

Length 12-17 µm; width 5-6 µm; raphe valve striae 15-16 in 10 µm; rapheless valve striae 12-14 in 10 µm.

Epiphytic on *Cladophora*, *Oedogonium* and *Vaucheria*.

Achnanthes lanceolata var. ***dubia*** Grunow (Figs. 37-40)

Length 13-17 µm; width 5-6 µm; raphe valve striae 12-14 in 10 µm; rapheless valve striae 14-15 in 10 µm.

Epiphytic on *Cladophora*, *Oedogonium* and *Vaucheria*.

Achnanthes microcephala (Kuetz.) Grun. var. ***microcephala*** (Figs. 41-50)

Length 12-25 µm; width 2-3 µm; raphe valve striae 26-28 in 10 µm at the ends; rapheless valve striae ca. 24-26 in 10 µm at the center, ca.32 in 10 µm at the ends.

Epiphytic on *Cladophora* and *Vaucheria*.

Achnanthes saxonica Krasske var. ***saxonica*** (Figs. 51-54)

Length 9-13 µm; width 2.5-3.5 µm; raphe valve striae 24-27 in 10 µm; rapheless valve striae 13-14 in 10 µm.

Epiphytic on *Cladophora* and *Oedogonium*.

Genus ***Cocconeis*** Ehr.

Cocconeis placentula Ehr. var. ***euglypta*** (Ehr.) Cl. (Figs. 55-60)

Length 19-27 µm; width 11-15 µm; raphe valve with 17-18 striae in 10 µm; rapheless valve with 20-22 striae in 10 µm.

Epiphytic on *Cladophora*, *Oedogonium* and *Vaucheria*.

Cocconeis scutellum Ehr. var. ***scutellum*** (Fig. 61)

Length 35-45 µm; width 28-36 µm; raphe valve with 6-7 striae in 10 µm; rapheless valve with 7 striae in 10 µm.

Epiphytic on *Cladophora*, *Rhizoclonium* and *Oedogonium*.

Family *NAVICULACEAE*

Genus ***Amphora*** Ehr.

Amphora perpusilla (Grun.) Grun. var. ***perpusilla*** (Figs. 62, 63).

Length 9-19 µm; width 3-5 µm; striae 17-19 in 10 µm.

Epiphytic on *Cladophora*.

Amphora veneta Kuetz. var. ***veneta*** (Figs. 64-72).

Length 13-30 µm; width 4-6 µm; striae 18-24 in 10 µm.

Epiphytic on *Cladophora*, *Rhizoclonium*, *Oedogonium*, *Hydrodictyon* and *Vaucheria*.

Genus ***Cymbella*** C.A. Agardh

Cymbella affinis Kuetz. var. ***affinis*** (Figs. 73-74).

Length 33-35 µm; width 8-10 µm; dorsal striae 10-11 in 10 µm; ventral striae 9-11 in 10 µm.

Epiphytic on *Cladophora*.

Cymbella minuta Hilse ex Rabh. var. ***silesiaca*** (Bleisch. ex. Rabh.) Reim. (Figs. 75-80).

Length 15-28 in 10 µm; width 6.5-9 µm; striae 11-15 in 10 µm.

Epiphytic on *Cladophora*, *Oedogonium* and *Vaucheria*.

Cymbella sinuata Greg. (Fig. 81).

Length 17-21 µm; width 5 µm; striae 12 in 10 µm.

Epiphytic on *Cladophora* and *Oedogonium*.

Cymbella tumida (Bréb. ex Kuetz.) V.H. var. ***tumida*** (Fig. 85).

Length 45-60 µm; width 16-18 µm; striae 8-12 in 10 µm.

Epiphytic on *Cladophora*.

Cymbella turgidula Grun. var. ***turgidula*** (Figs. 82-84).

Length 28-34 µm; width 8-9 µm; dorsal striae 9-11 in 10 µm; ventral striae 10-12 in 10 µm.

Epiphytic on *Cladophora* and *Vaucheria*.

Genus ***Frustulia*** Rabh.

Frustulia vulgaris (Thwaites) De Toni var. ***vulgaris*** (Figs. 86-87).

Length 50-52 µm; width 9-10 µm; striae 25-28 in 10 µm.

Epiphytic on *Cladophora*, *Oedogonium* and *Vaucheria*.

Genus ***Gomphonema*** Ehr.

Gomphonema acuminatum Ehr. var. ***acuminatum*** (Figs. 88-90).

Length 31-59 µm; width 9-12 µm; striae 9-11 in 10 µm.

Epiphytic on *Cladophora*.

Gomphonema affine Kuetz. var. ***affine*** (Figs. 91-92).

Length 40-56 µm; width 8-10 µm; striae 10-11 in 10 µm.

Epiphytic on *Cladophora*.

Gomphonema gracile Ehr. emend. V. H. var. ***gracile*** (Fig. 93).

Length 28-40 µm; width 5.5-8 µm; striae 13-14 in 10 µm.

Epiphytic on *Cladophora*.

Gomphonema parvulum Kuetz. var. ***parvulum*** (Figs. 94-100).

Length 17-24 µm; width 6-9 µm; striae 12-16 in 10 µm.

Epiphytic on *Cladophora*, *Hydrodictyon* and *Oedogonium*.

Gomphonema subclavatum (Grun.) Grun. var. ***subclavatum*** (Fig. 101).

Length 30-34 µm; width 7-8 µm; striae 10-12 um in 10 µm.

Epiphytic on *Cladophora*, *Hydrodictyon* and *Vaucheria*.

Gomphonema subclavatum var. ***commutatum*** (Grun.) A. Mayer (Fig. 102).

Length 38-41 µm; width 7-8 µm; striae 10-11 in 10 µm.

Epiphytic on *Oedogonium*.

Gomphonema subclavatum var. ***mexicanum*** (Grun.) Patr. (Figs. 103-109).

Length 29-32 µm; width 7-8 µm; striae 11-13 in 10 µm.

Epiphytic on *Cladophora* and *Hydrodictyon*.

Gomphonema tenellum Kuetz. var. ***tenellum*** (Figs. 110-112).

Length 18-30 µm; width 4.5-6 µm; striae 10-11 in 10 µm.

Epiphytic on *Cladophora*, *Oedogonium* and *Vaucheria*.

Gomphonema truncatum Ehr. var. ***truncatum*** (Figs. 113-117).

Length 40-52 µm; width 10-11 µm; striae 9-11 in 10 µm.

Epiphytic on *Cladophora* and *Vaucheria*.

Genus ***Gomphoneis*** Cleve

Gomphoneis herculeana (Ehr.) Cl. var. ***robusta*** (Grun.) Cl. (Figs. 118-119).

Length 70-85 µm; width 22-24 µm; striae 11-12 in 10 µm.

Epiphytic on *Cladophora*, *Oedogonium* and *Hydrodictyon*.

Genus ***Navicula*** Bory

Navicula cryptocephala Kuetz. var. ***veneta*** (Kuetz.) Rabh. (Figs. 120-123).

Length 16.5-26 µm; width 5-6 µm; striae 13-17 in 10 µm.

Epiphytic on *Cladophora* and *Oedogonium*.

Navicula mutica Kuetz. var. ***mutica*** (Figs. 124-125).

Length 30-32 µm; width 7-8 µm; striae 16-18 in 10 µm.

Epiphytic on *Cladophora* and *Oedogonium*.

Navicula pupula Kuetz. var. ***pupula*** (Fig. 126).

Length 21-28 µm; width 7.5-8.5 µm; striae 16-18 in 10 µm at the center, ca. 24 at the ends.

Epiphytic on *Cladophora*, *Oedogonium* and *Hydrodictyon*.

Navicula salinarum Grun. var. ***intermedia*** (Grun.) Cl. (Figs. 127-128).

Length 35-48 µm; width 8 µm; striae 10-12 in 10 µm.

Epiphytic on *Cladophora* and *Oedogonium*.

Navicula aff. ***tripunctata*** (O.F. Müller) Bory. (Fig. 129).

Length 42 µm; width 8 µm; striae 11 in 10 µm.

Epiphytic on *Cladophora*.

Navicula viridula (Kuetz.) Kuetz. var. ***avenacea*** (Bréb. ex Grun.) V.H. (Figs. 130-132).

Length 53-57.5 µm; width 9-10 µm; striae 10-12 in 10 µm at the center.

Epiphytic on *Cladophora, Oedogonium, Hydrodictyon* and *Vaucheria*.

Genus ***Rhoicosphenia*** Grun.

Rhoicosphenia curvata (Kuetz.) Grun. var. ***curvata***. (Figs. 133-134).

Length 30-35 µm; width 5-6 µm; striae 10-12 in 10 µm at the center, 17-18 in 10 µm at the ends.

Epiphytic on *Oedogonium*.

Family EPITHEMIACEAE

Genus ***Epithemia*** Bréb.

Epithemia adnata (Kuetz.) Bréb. var. ***adnata.*** (Figs. 135-137).

Length 65-90 µm; width 8-11 µm; costae 3-6 in 10 µm; rows of alveoli between costae 4-5

Epiphytic on *Cladophora* and *Vaucheria*.

Epithemia adnata var. ***proboscidea*** (Kuetz.) Patr. (Figs. 138-141).

Length 48-56 µm; width 9-10 µm; costae 4-6 in 10 µm; rows of alveoli 11-14 in 10 µm.

Epiphytic on *Cladophora, Rhizoclonium* and *Vaucheria*.

Epithemia sorex Kuetz. var. ***sorex*** (Figs. 142-144).

Length 38-40 µm; width 9-10 µm; costae 8-10 in 10 µm; rows of alveoli 12-15 in 10 µm.

Epiphytic on *Cladophora, Oedogonium* and *Vaucheria*.

Genus ***Rhopalodia*** O. Müller

Rhopalodia gibba (Ehr.) O. Müller var. ***ventricosa*** (Kuetz.) H. et M. Perag. (Figs. 145-148).

Length 65-80 µm; width 17-19 µm; costae 6-8 in 10 µm; striae 12-14 in 10 µm.

Epiphytic on *Cladophora*.

Rhopalodia musculus (Kuetz.) O. Müller var. ***musculus.*** (Fig. 149).

Length 28-30 µm; width 7-8 µm; costae 4-5 in 10 µm; striae ca. on 14 in 10 µm. Epiphytic in *Cladophora*.

Family NITZSCHIACEAE

Genus ***Hantzschia*** Grunow

Hantzschia amphioxys (Ehr.) Grun. (Fig. 150).

Length 32-35 µm; width 7-8 µm; keel punctae 6-7 in 10 µm; striae 19-20 in 10 µm.

Epiphytic on *Cladophora*.

Genus ***Nitzschia*** Hassall

Nitzschia amphibia Grun. (Figs. 151-155).

Length 21-34 µm; width 3.5-5 µm; keel punctae 6-8 in 10 µm; striae 15-16 in 10 µm.

Epiphytic on *Cladophora, Oedogonium, Hydrodictyon* and *Vaucheria*.

Nitzschia frustulum (Kuetz.) Grun. (Figs. 156-160).

Length 12-39 µm; width 3.5-4.5 µm; keel punctae 10-12 in 10 µm; striae 18-25 in 10 µm.

Epiphytic on *Cladophora, Oedogonium* and *Hydrodictyon*.

Nitzschia aff. ***inconspicus*** Grun. (Figs. 161-162).

Length 5-7 µm; width 3-4 µm; keel punctae 12-13 in 10 µm; striae ca. 24 in 10 µm.

Epiphytic on *Cladophora*.

Nitzschia palea (Kuetz.) W. Smith (Figs. 163-164).

Length 18-30 µm; width 3-4 µm; keel punctae 12-16 in 10 µm; striae ca. 40 in 10 µm.

Epiphytic on *Cladophora, Oedogonium, Hydrodictyon* and *Vaucheria.*

Family SURIRELLACEAE

Genus ***Surirella*** Turpin

Surirella angusta Kuetz. (Fig. 168).
Length 22-24 µm; width 8-9 µm; costae 6-7 in 10 µm; striae ca. 20 in 10 µm.
Epiphytic on *Oedogonium.*

Surirella aff. ***ovata*** Kuetz. (Figs. 165-167).
Length 27-33 µm; width 10-11 µm; costae 6-7 in 10 µm; striae 18-22 in 10 µm.
Epiphytic on *Cladophora* and *Oedogonium.*

CONCLUSIONS

It is important to point out that the results of this investigation are based on a small number of samples (17) from thirteen different localities; however, it is also relevant to indicate that the thirteen localities represent quite different lotics habitats from the central to the north part of Chile. Tables I and II summarize the result obtained in this study.

A total of 55 taxa belonging to 18 genera of diatoms were determined.

The most common and abundant epiphytic diatoms were *Achnanthes lanceolata* var. *lanceolata, Amphora veneta* var. *veneta, Cocconeis placentula* var. *euglypta, Fragilaria vaucheriae* var. *vaucheriae, Gomphonema parvulum* var. *parvulum, Nitzschia amphibia, Nitzschia frustulum, Nitzschia palea, Synedra fasciculata* var. *fasciculata* and *Synedra ulna* var. *ulna* (see Table N° I).

The highest richness of species were found on *Cladophora glomerata* which had 52 taxa of a whole of 55 determined taxa; followed by *Oedogonium* spp. (31). The lowest richness of species occurred on *Rhizoclonium hieroglyphicum* (6) (see Table N° II).

Achnanthes, Cymbella, Gomphonema, Navicula and *Synedra* were the genera which presented the highest number of taxa (see Table N° I).

Only three taxa were common to all studied genera: i.e., *Amphora veneta* var. *veneta, Nitzschia amphibia* and *Nitzschia palea. Synedra ulna* occurred in four and as the former with a high frequency and abundance.

Contrarily, 18 taxa were found present on one genus, particulary on *Cladophora* and four of them with a relatively high frequency, i.e., *Amphora perpusilla* var. *perpusilla, Cymbella affinis* var. *affinis, Gomphonema acuminatum* var. *acuminatum, Gomphonema affine* var. *affine.*

On the other hand, the genus *Rhopalodia* with *R. gibba* var. *ventricosa* and *R. musculus* var. *musculus,* was present only on *Cladophora* and the genus *Rhoicosphenia* with *R. curvata* occurred only on *Oedogonium.*

It is interesting to compare the species composition of filamentous algae from similar sampling sites, e.g., samples N° 1412 with *Cladophora* and N° 1413 with *Vaucheria* from Estero Conchali; N° 1632 from Río Angostura with *Cladophora* and *Hydrodictyon;* N° 1647 and N° 1650 with *Oedogonium* and *Cladophora* respectively from Estero Rigoleno and sample N° 1667 from Río Guaiquillo where *Cladophora* and *Hydrodictyon* were growing.

In Estero Conchali (N° 1412 and N° 1413) *Cladophora* presented 8 epiphytic diatoms, being *Synedra fasciculata* var.*fasciculata* and *Epithemia adnata* the most abundant; on the other hand on *Vaucheria* occurred 15 taxa of diatoms with an abundance of *Epithemia adnata* var. *adnata, Synedra fasciculata* var. *fasciculata* and *Achnanthes hungarica.* Thus, in Estero Conchali *Cladophora* and *Vaucheria* shared 7 taxa from a total of 16 presented as epiphytes on both genera and the same taxa which were abundant.

In Río Angostura (N° 1632), *Cladophora* and *Hydrodictyon* shared 5 taxa from a whole of 8 taxa presented as epiphytes on both genera, among which the most abundant were: *Amphora veneta* var. *veneta*, *Gomphonema parvulum* var. *parvulum* and *Gomphonema subclavatum* var. *subclavatum*.

Oedogonium and *Cladophora*, which were growing in Estero Rigoleno (N° 1647 and N° 1650) presented 19 taxa of epiphytic diatoms, six of them were shared and in contrast to previous findings the abundant species were different, i.e., *Gomphonema tenellum* var. *tenellum* and *Gomphonema herculeana* var. *robusta* were dominant on *Cladophora* and *Synedra ulna* var. *ulna*, *Nitzschia palea*, *Surirella* aff. *ovata* and *Gomphonema parvulum* var. *parvulum* were dominant on *Oedogonium*.

Finally, in sample N° 1667, where 14 taxa were found growing on *Cladophora* and *Hydrodictyon*, seven taxa were present on both of them but the other seven taxa were only present on *Cladophora*. They shared only one dominant species, i.e., *Amphora veneta* var. *veneta*, but not the other dominant, *Synedra ulna* var. *ulna* and the subdominants *Gomphonema parvulum* var. *parvulum*, *Nitzschia amphibia* and *Nitzschia palea*.

The results of this preliminary investigation reveal that the host-epiphyte specificity, referred to the association of filamentous algae and attached diatoms is questionable and further research is needed on the matter.

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EXPLANATION OF FIGURES

Figs. 1,2 *Ceratoneis arcus* Ehr. var. *arcus*.; valve view (LM).

Figs. 3,4 *Diatoma tenue* Ag. var. *tenue*.
3 Valve view (SEM)
4 Valve view (LM)

Figs. 5,6 *Fragilaria brevistriata* Grun. var. *brevistriata*; valve view (LM).

Fig. 7 *Fragilaria construens* (Ehr.) Grun. var. *venter* (Ehr.) Grun.; valve view (LM).

Figs. 8,9 *Fragilaria pinnata* Ehr. var. *pinnata*; valve view (LM).

Figs. 10-14 *Fragilaria vaucheriae* (Kuetz.) Peters. var. *vaucheriae*.
10,11 valve views (LM)
12,14 valve views (SEM)

Fig. 15 *Synedra acus* Kuetz. var. *acus*; valve view (LM)

Figs. 16,17 *Synedra fasciculata* (Ag.) Kuetz. var. *fasciculata*.
16 valve view (LM)
17 valve view (SEM)

Fig. 18 *Synedra pulchella* Ralfs ex Kuetz. var. *pulchella*; valve view (LM)

Figs. 19,20 *Synedra rumpens* Kuetz. var. *familiaris* (Kuetz.) Hust.
19 valve view (LM)
20 valve view (TEM)

Figs. 21-26 *Synedra ulna* (Nitz.) Ehr.
21,22 valve views (LM)
23 central area (LM)
24 valve view (TEM)
25 internal polar view (SEM)
26 internal central area view (SEM)

Figs. 27-30 *Achnanthes hungarica* Grun.
27,28 valve views (LM)
29 valve view (SEM)
30 valve view (SEM)

Figs. 31-36 *Achnanthes lanceolata* (Bréb.) Grun. var. *lanceolata*.
31,32 raphe valve views (LM)
33,35 rapheless valve views (LM)
36 rapheless valve view (SEM)

Figs. 37-40 *Achnanthes lanceolata* var. *dubia* Grun.
37,38 raphe and rapheless valve views (LM)
39 internal rapheless valve view (TEM)
40 internal polar raphe valve view (SEM)

Figs. 41-47 *Achnanthes microcephala* (Kuetz.) Grun. var. *microcephala*
41 raphe valve view (LM)
42,43,46 raphe valve views (SEM)

44,45 raphe valve views (TEM)
47 central area view (TEM)

Figs. 48-50 *Achnanthes microcephala* (Kuetz.) Grun. var. *microcephala*
48,49 rapheless valve views (TEM)
50 internal polar rapheless valve view (TEM)

Figs. 52-54 *Achnanthes saxonica* Krasske var. *saxonica*
52 raphe valve view (TEM)
53 internal raphe valve view (SEM)
54 external raphe valve view (SEM)

Figs. 55-60 *Cocconeis placentula* Ehr. var. *euglypta* (Ehr.) Cleve
55,56 raphe and rapheless valve views (LM)
57 internal raphe valve view (SEM)
58 external raphe valve view (SEM)
59 external rapheless valve view (SEM)
60 internal rapheless valve view (SEM)

Figs. 61 *Cocconeis scutellum* Ehr. var. *scutellum*; rapheless valve view (LM)

Figs. 62,63 *Amphora perpusilla* (Grun.) Grun. var *perpusilla*
62 valve view (LM)
63 valve view (TEM)

Figs. 64-72 *Amphora veneta* Kuetz. var. *veneta*
64,66 valve views (LM)
67 girdle view (LM)
68,69 valve view (SEM)
70 valve view (TEM)
71 girdle view (SEM)
72 external central raphe endings (SEM)

Figs. 73,74 *Cymbella affinis* Kuetz. var. *affinis;* valve views (LM)

Figs. 75-80 *Cymbella minuta* Hilse ex Rabh. var. *silesiaca* (Bleisch.)
75,77 valve views (LM)
78 valve view (TEM)
79 external central raphe endings (TEM)
80 polar raphe ending (TEM)

Fig. 81 *Cymbella sinuata* Greg.; valve view (LM)

Figs. 82-84 *Cymbella turgidula* Grun. var. *turgidula*
82 valve view (LM)
83,84 valve view (SEM)

Fig. 85 *Cymbella tumida* (Bréb. ex. Kuetz.) V.H. var. *tumida;* valve view (LM).

Figs. 86,87 *Frustulia vulgaris* (Thw.) De Toni var. *vulgaris*
86 valve view (LM)
87 valve view (SEM)

Figs. 88-90 *Gomphonema acuminatum* Ehr. var. *acuminatum*
88 external central area (TEM)
89 valve view (LM)
90 valve view (TEM)

Figs. 91,92 *Gomphonema affine* Kuetz. var. *affine;* valve views (LM)

Fig. 93 *Gomphonema gracile* Ehr. emend V.H. var. *gracile;* valve view (LM)

Figs. 94-100 *Gomphonema parvulum* Kuetz. var *parvulum;* valve views (LM).

Fig. 101 *Gomphonema subclavatum* Grun. var. *subclavatum;* valve view (LM)

Fig. 102 *Gomphonema subclavatum* var. *commutatum* (Grun.) A. Mayer; valve view (LM)

Figs. 103-109 *Gomphonema subclavatum* var. *mexicanum* (Grun.) Patr.
103,104 valve views (LM)
105 external valve view (SEM)
106 internal valve view (SEM)
107 girdle view (SEM)
108 external central area view (SEM)

109 internal central area view (SEM).

Figs. 110-112 *Gomphonema tenellum* Kuetz. var. *tenellum*.
110,111 valve views (LM).
112 internal valve view (SEM)

Figs. 113-117 *Gomphonema truncatum* Ehr. var. *truncatum*
113,114 valve views (LM)
115 external central area view (TEM)
116 valve view (SEM)
117 valve view (TEM).

Figs. 118,119 *Gomphonema herculeana* (Ehr.) Cleve var. *robusta*. (Grun.) Cleve; valve views (LM).

Figs. 120-123 *Navicula cryptocephala* Kuetz. var. *veneta* (Kuetz.) Rabh.
120,121 valve views (LM)
122,123 external valve views (SEM)

Figs. 124,125 *Navicula mutica* Kuetz. var. *mutica;* valve views (LM).

Fig. 126 *Navicula pupula* Kuetz. var,. *pupula;* valve view (LM)

Figs. 127,128 *Navicula salinarum* Grun. var. *intermedia* (Grun.) Cleve; valve views (LM)

Fig. 129 *Navicula* aff. *tripunctata* (O.F. Müller) Bory; valve view (LM)

Figs. 130-132 *Navicula viridula* Kuetz. var. *avenacea* (Bréb. ex. Grun.) V.H.
129,131 valve views (LM)
132 external valve view (SEM)

Figs. 133,134 *Rhoicosphenia curvata* (Kuetz.) Grun.
133 valve view (LM)
134 girdle view (LM)

Figs. 135-137 *Epithemia adnata* (Kuetz.) Bréb. var. *adnata*
135,136 valve views (LM)
137 valve view (SEM)

Figs. 138-141 *Epithemia adnata* var. *proboscidea* (Kuetz.) Patr.
138,139 valve views (LM)
140 central valve view (SEM)
141 valve view (SEM)

Figs. 142-144 *Epithemia sorex* Kuetz. var. *sorex*
142 valve view (LM)
143,144 internal valve view (SEM)

Figs. 145-148 *Rhopalodia gibba* (Ehr.) O. Müller var. *ventricosa*.
145, valve view (LM)
146,147 valve views (SEM)
148 external polar valve view (SEM)

Fig. 149 *Rhopalodia musculus* (Kuetz.) O. Müller var. *musculus;* valve view (LM)

Fig. 150 *Hantzschia amphioxis* (Ehr.) Grun.; valve view (LM)

Figs. 151-155 *Nitzschia amphibia* Grun.;
151 valve view (LM)
152,153 external valve views (SEM)
154 internal valve view (SEM)
155 valve view (TEM)

Figs. 156-160 *Nitzschia frustulum* (Kuetz.) Grun.
156,157 valve views (LM)
158 internal valve view (SEM)
159,160 valve views (TEM)

Figs. 161,162 *Nitzschia* aff. *inconspicua* Grun.; valve views (LM)

Figs. 163,164 *Nitzschia palea* (Kuetz.) W. Smith; valve views (LM)

Figs. 165-167 *Surirella* aff. *ovata* Kuetz.
165,166 valve views (LM)
167, valve view (SEM)

Fig. 168 *Surirella angusta* Kuetz.; valve view (LM)

Fig. 169 *Gomphonema tenellum* Kuetz. var. *tenellum* on *Cladophora glomerata* (SEM)

Fig. 170 *Gomphonema* sp. in girdle view with a short stalk on *Cladophora glomerata* (SEM)

Fig. 171 *Gomphonema truncatum* with a short stalk on *Cladophora glomerata* (SEM)

Fig. 172 *Gomphonema truncatum* with a stalk on *Oedogonium* sp. (SEM)

Fig. 173 Groups of *Synedra sp.* on a branch of *Cladophora glomerata* (SEM)

Fig. 174 Attachment of *Synedra* sp. and some *Gomphonema* sp. on *Cladophora glomerata* (SEM)

Fig. 175 *Synedra* sp. on *Cladophora glomerata* (LM)

Fig. 176 Bushe of *Synedra* sp. on *Cladophora glomerata* (LM)

Fig. 177 *Epithemia adnata* var. *proboscidea* on *Cladophora glomerata* (LM)

Fig. 178 *Rhoicosphenia curvata* on *Cladophora glomerata* (LM)

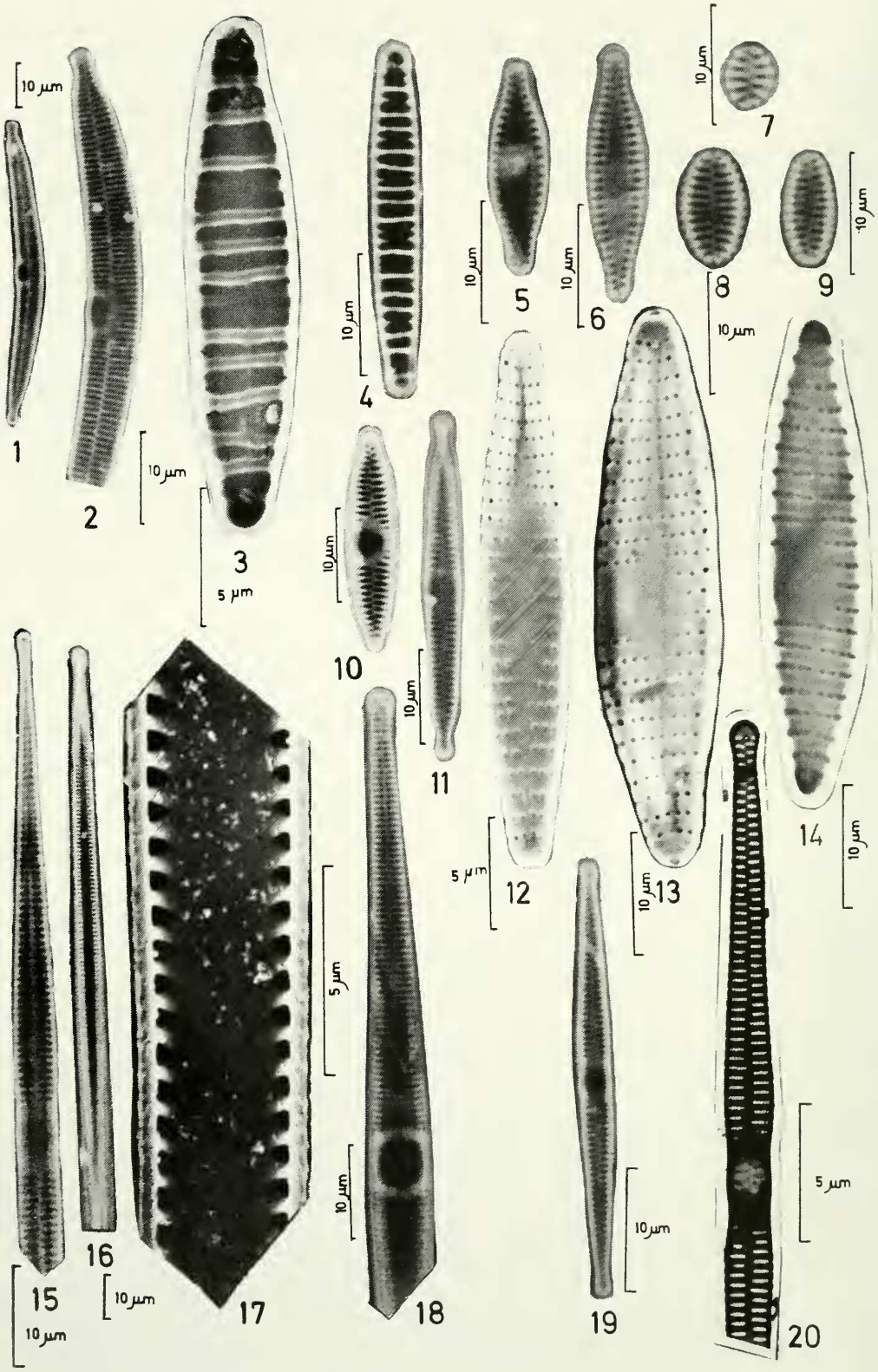
Fig. 179 *Gomphonema truncatum* on *Cladophora glomerata* (LM)

Fig. 180 Diatom assemblage on *Cladophora glomerata* (LM)

Fig. 181 *Cocconeis placentula* var. *euglypta* on *Cladophora glomerata* (LM)

Fig. 182 *Gomphonema truncatum* with stalks and bushes of *Synedra* sp. on *Cladophora glomerata* (LM)

Fig. 183 *Amphora veneta* on *Hydrodictyon reticulatum* (LM)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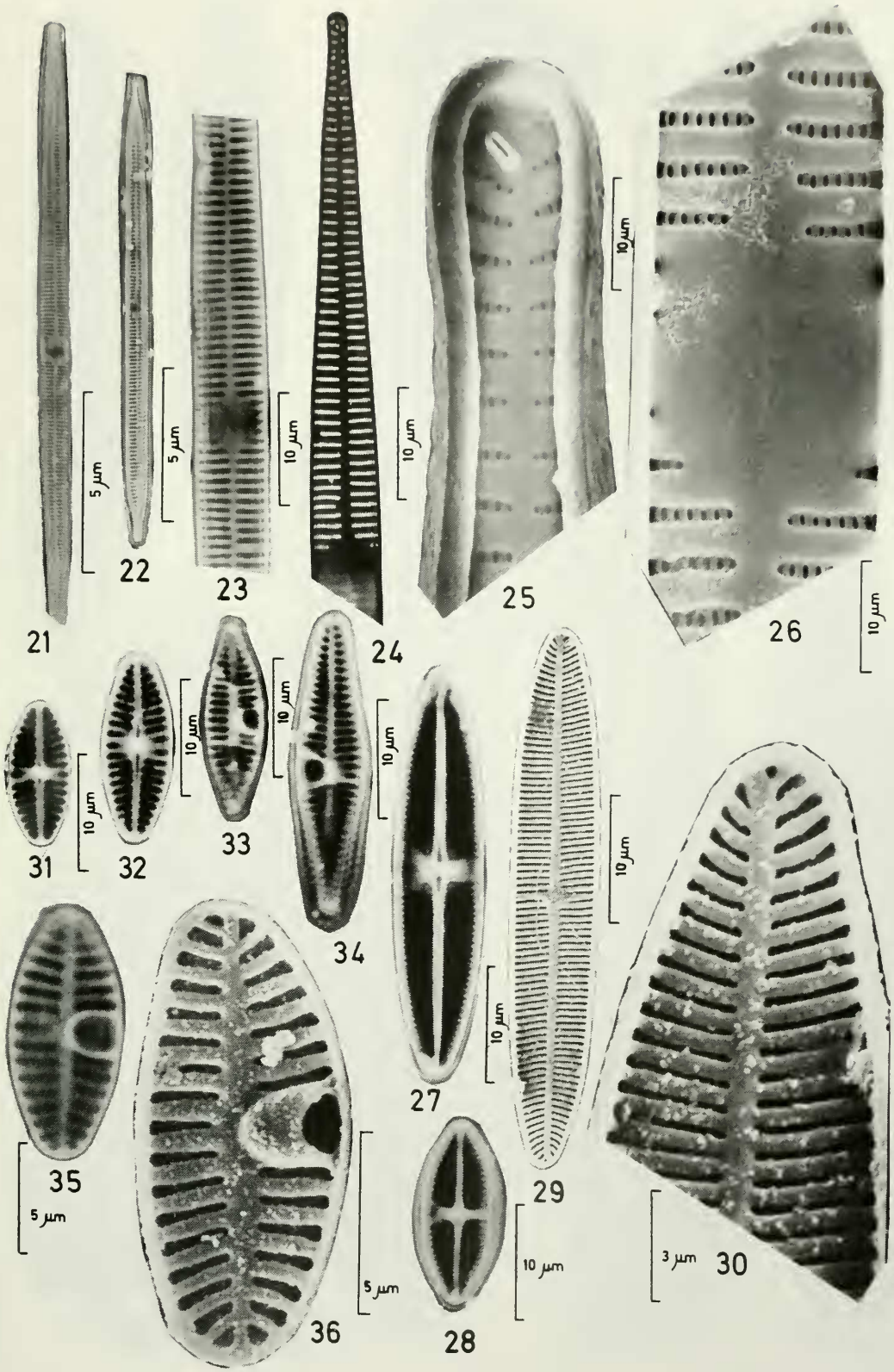
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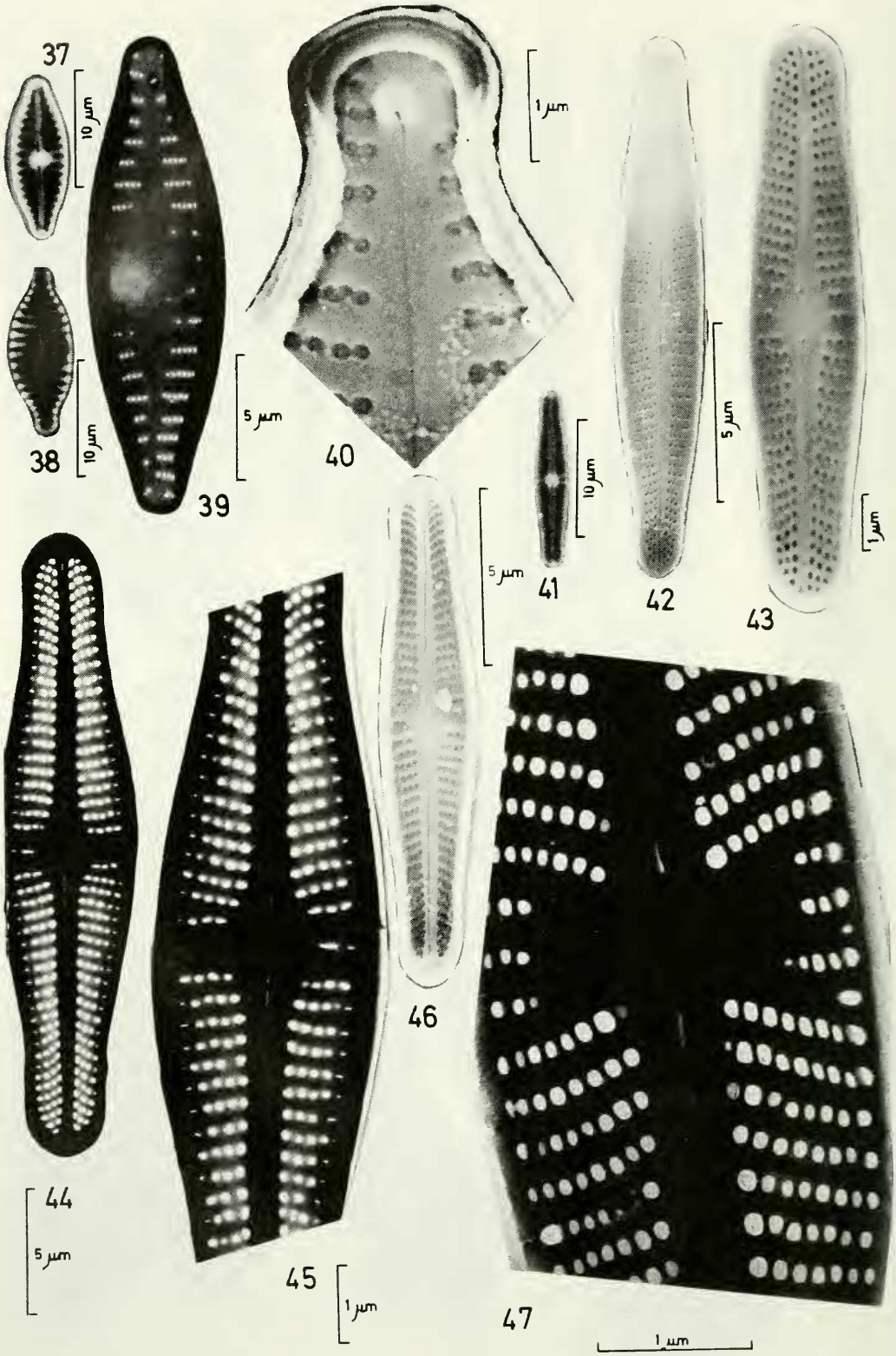
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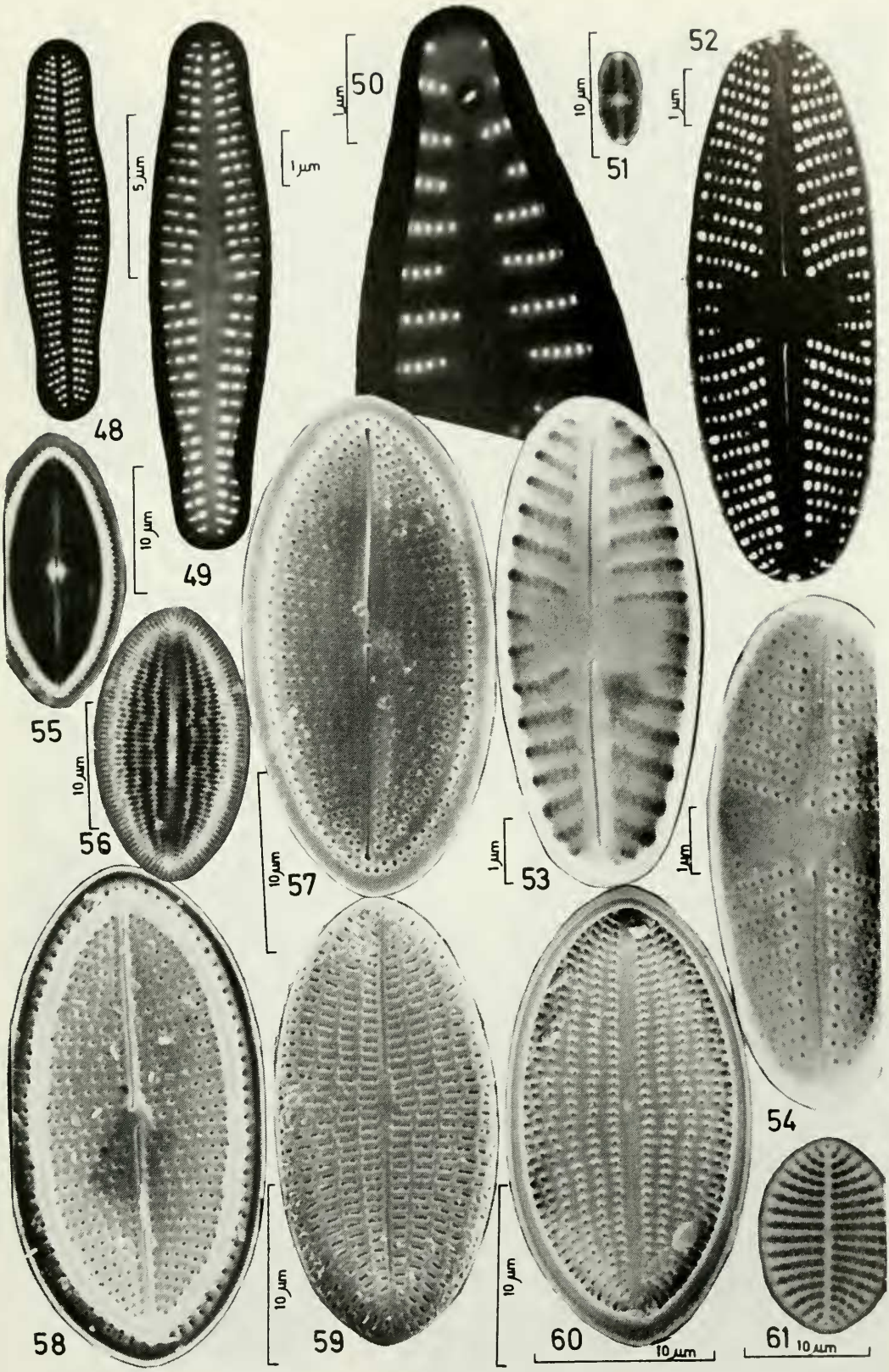
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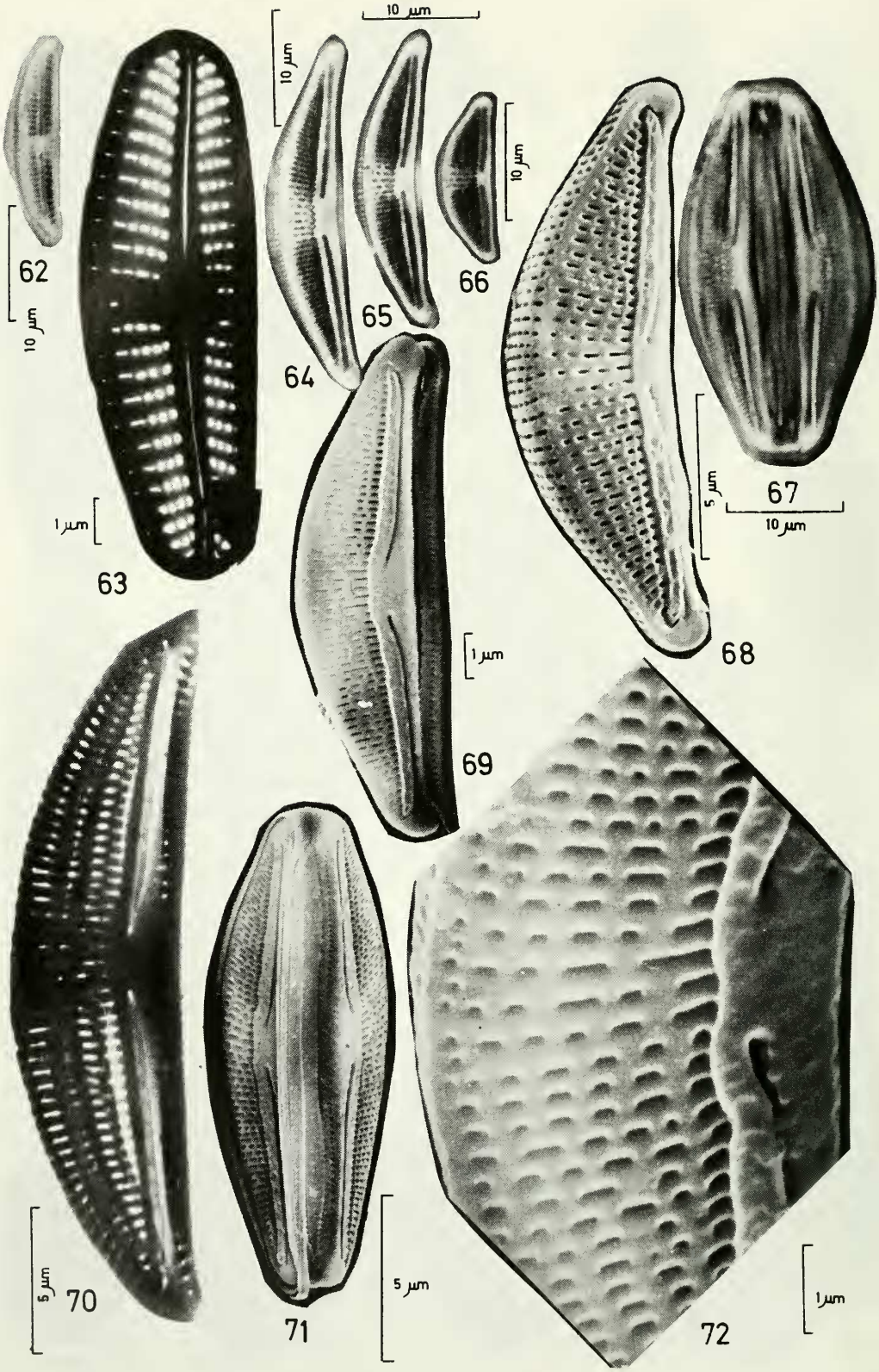
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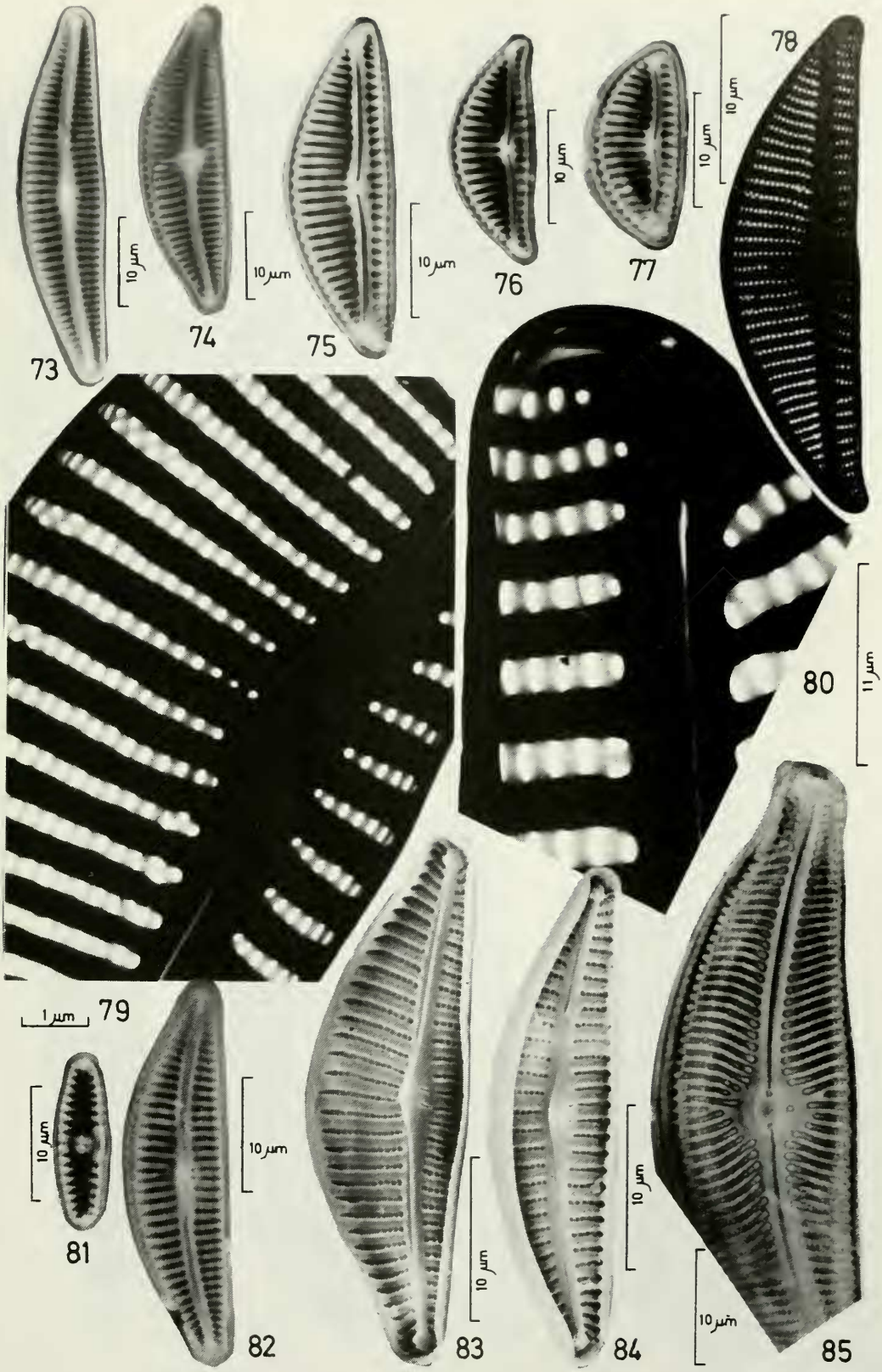
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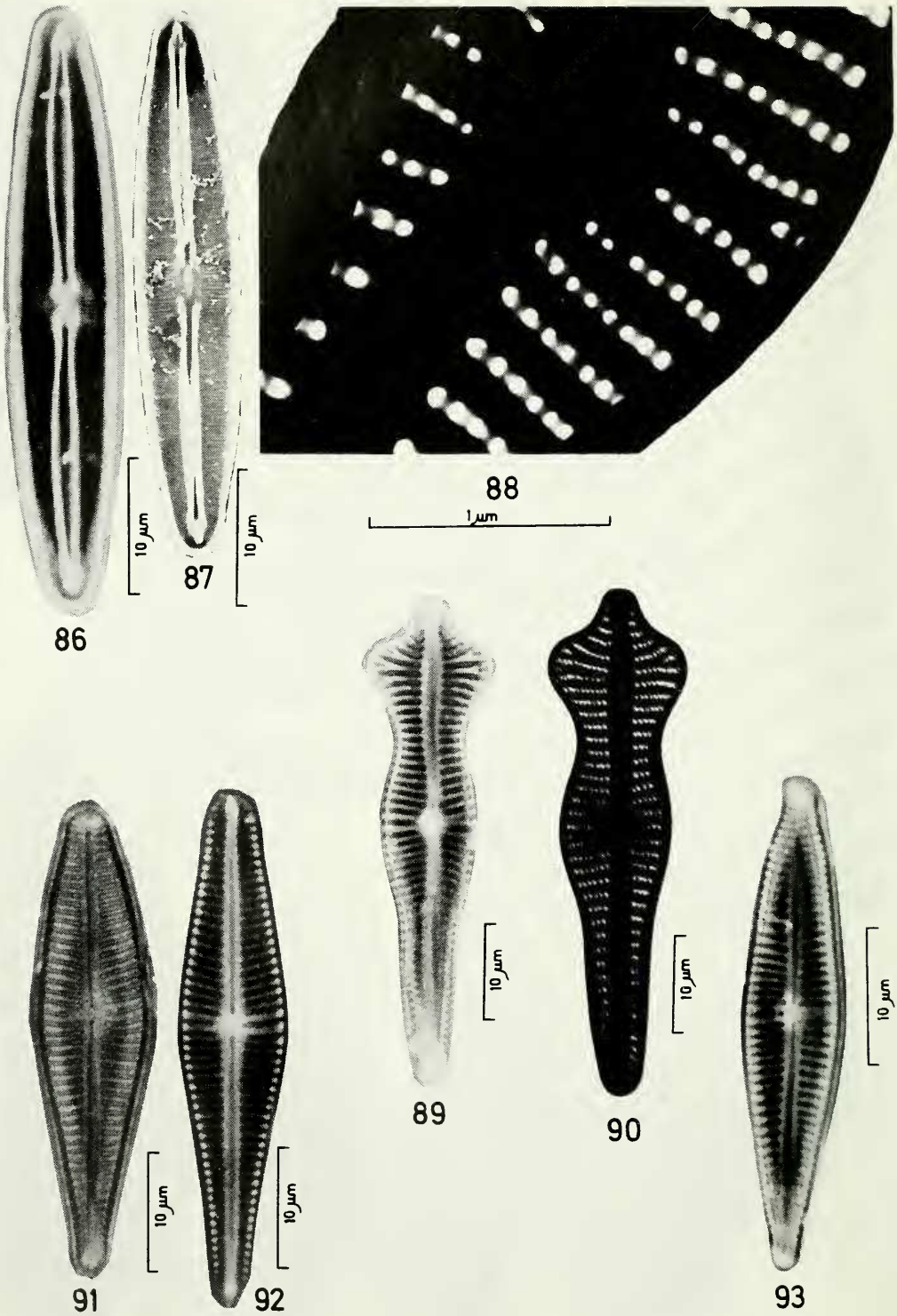
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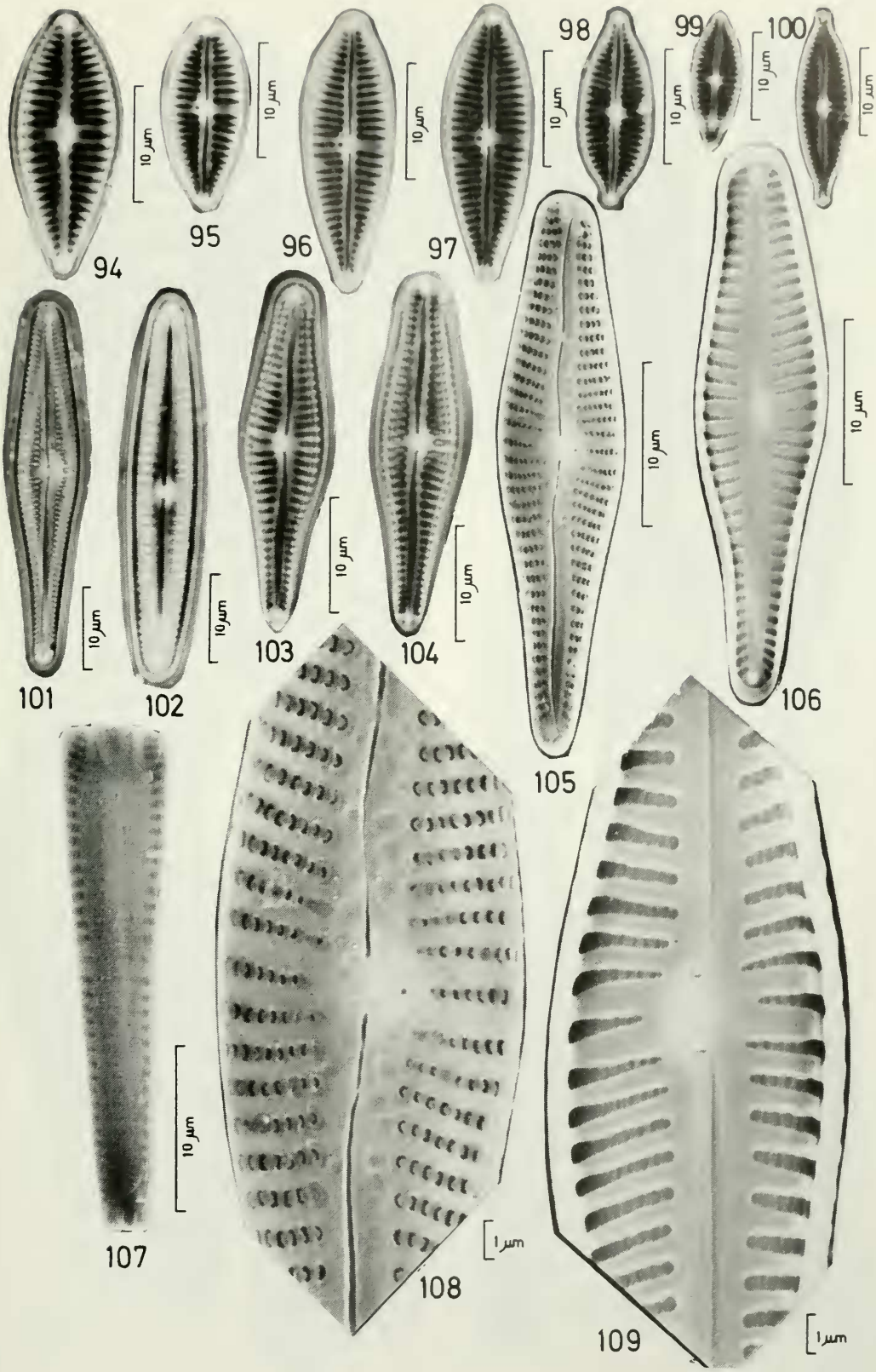
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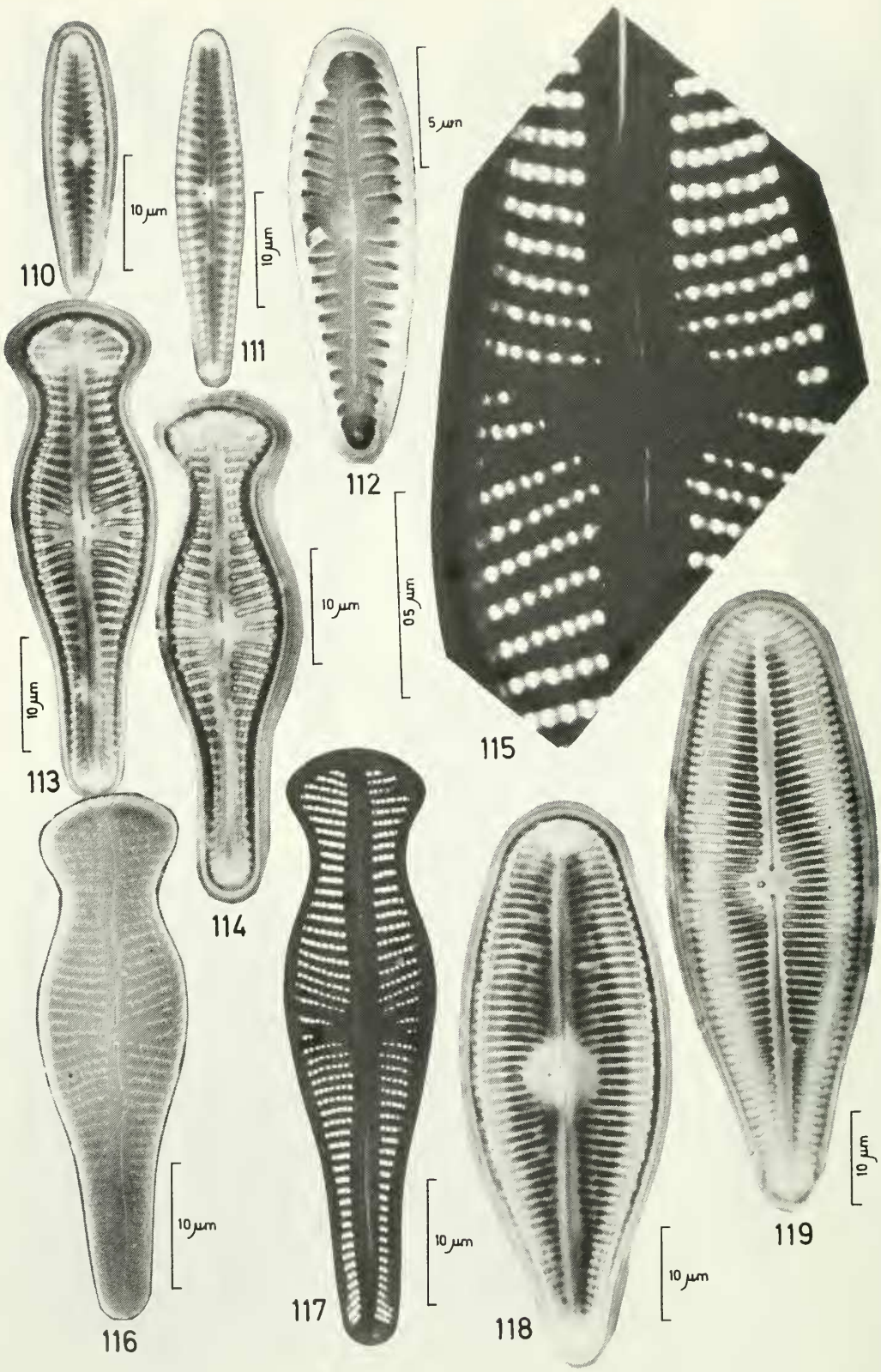
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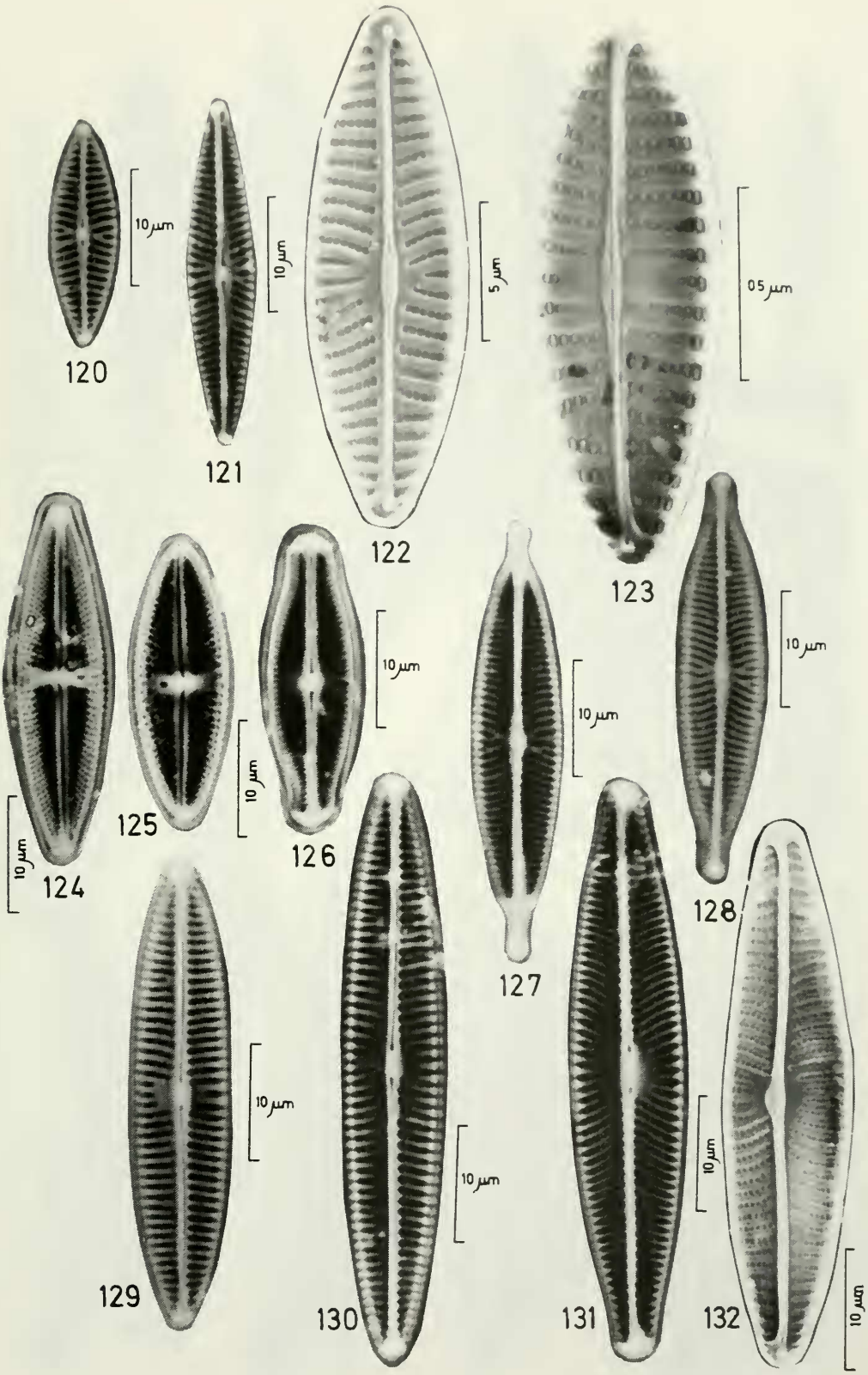
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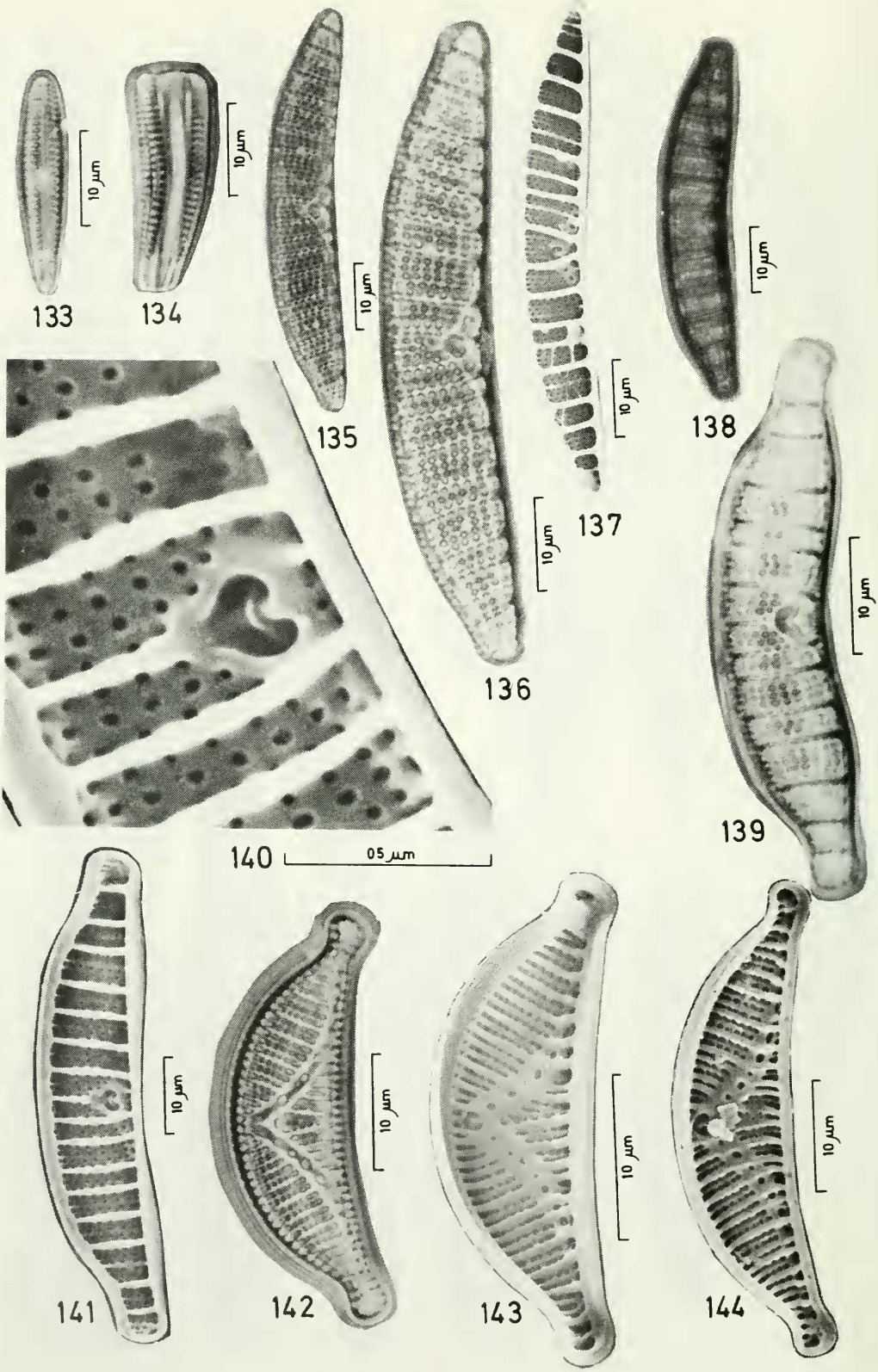
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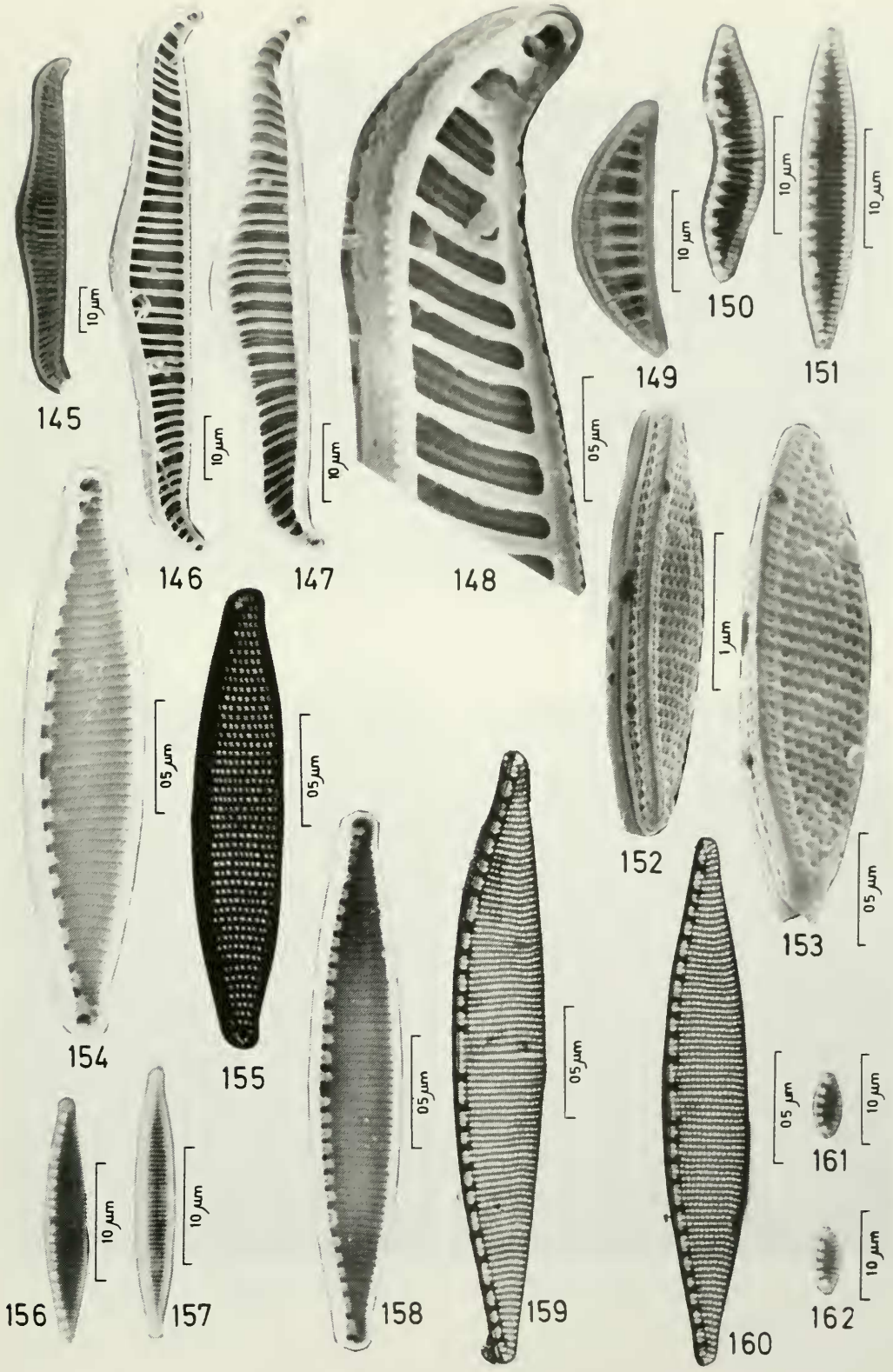
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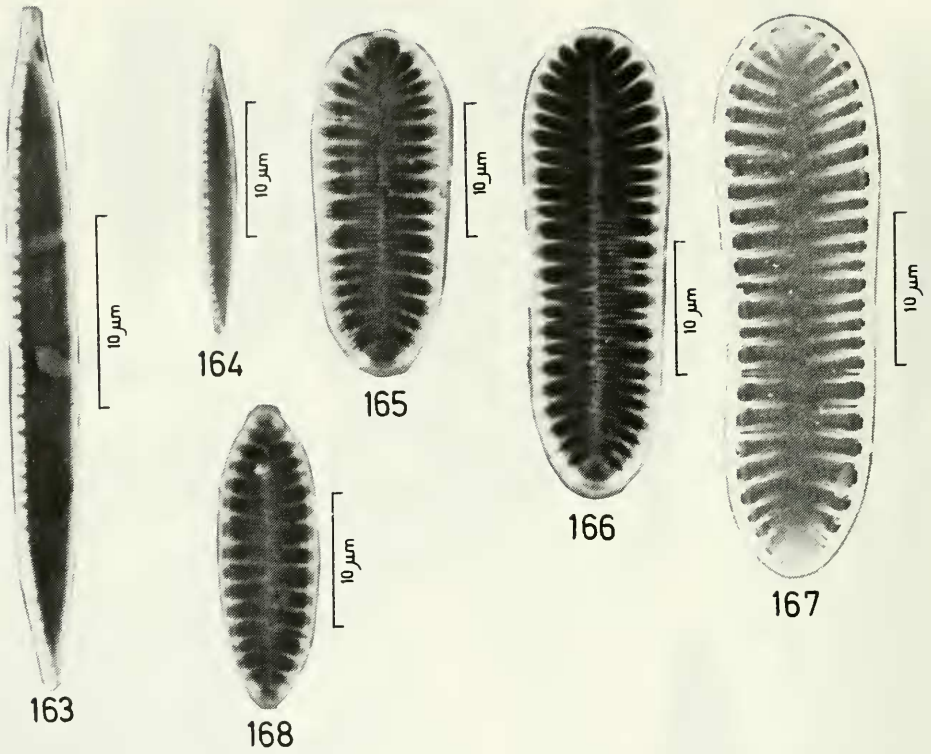
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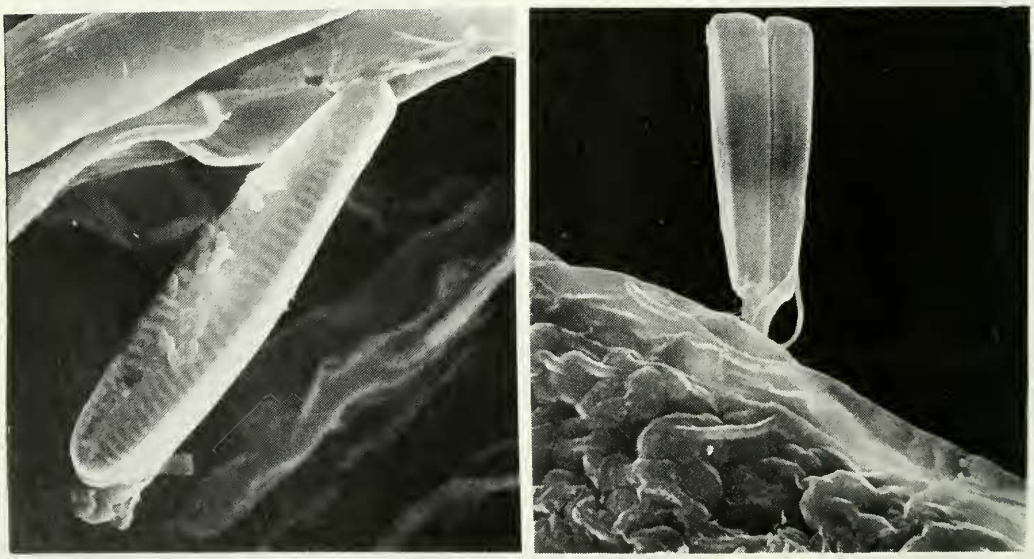
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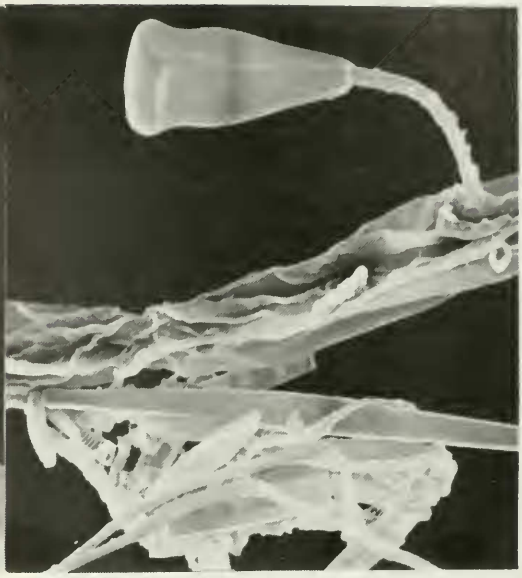

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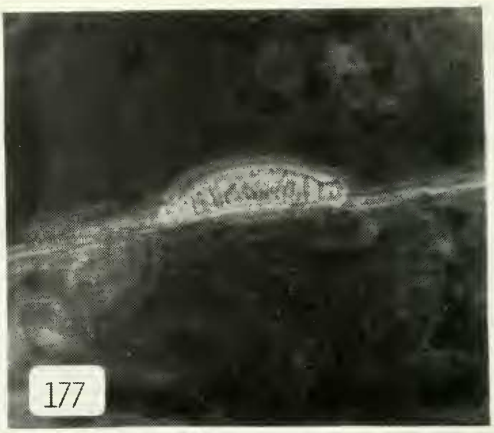
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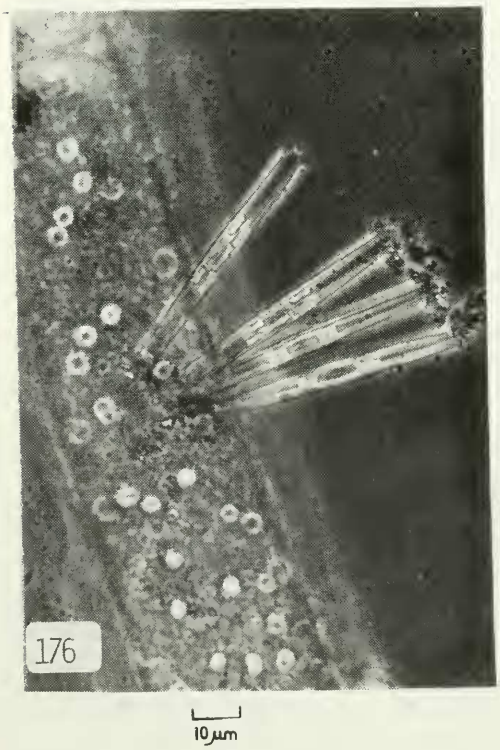
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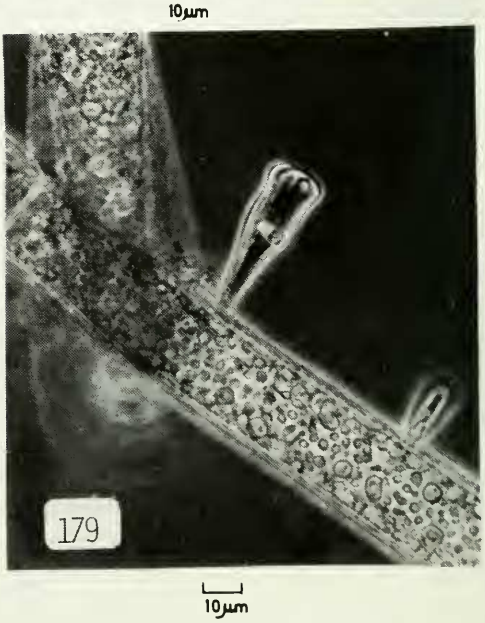
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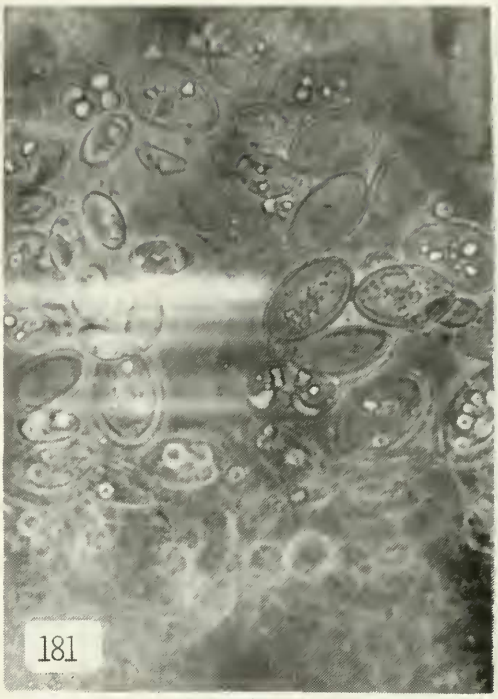
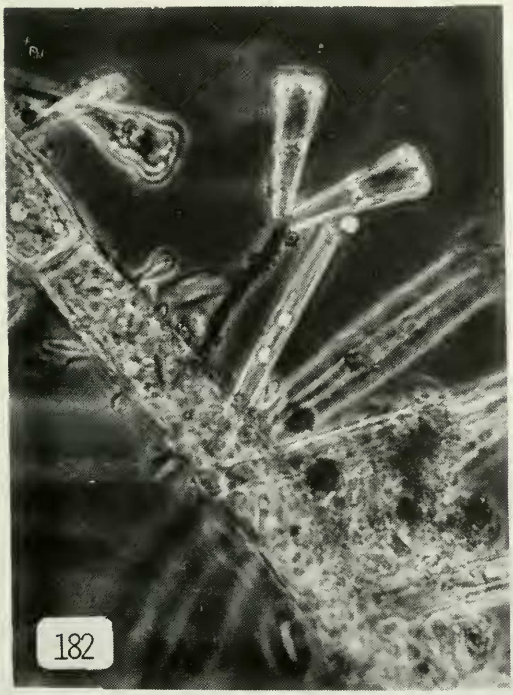


10 μm



10 μm

10 μm

TABLE N° I. Taxa distribution in the studied samples of each genera.

	CLADOPHORA										RHIZOCLONIUM	OEDOGONIUM					HYDRODICTYION		VAUCHERIA	
	1412	1416	1417	1418	1419	1632	1637	1650	1667	1670	1425	1423	1459	1643	1647		1632	1667	1413	1451
Achnanthes hungarica *var.*hungarica		X	X				X												F	
Achnanthes lanceolata *var.* lanceolata	X	X	X	X	X		X		X					X					X	X
Achnanthes lanceolata *var.* dubia		X													X				X	
Achnanthes microcephala *var.* microcephala		A	X		X		X			X										X
Achnanthes saxonica *var.* saxonica		X							X					X						
Amphora perpusilla *var.* perpusilla		X	X				X													
Amphora veneta *var.* veneta	X	X	X		X	P			P		X	X	A		X		P	P	X	
Ceratoneis arcus *var.* arcus					X										X					
Cocconeis placentula *var.* euglypta		X	X	P	P			X		X			P	F					X	P
Cocconeis scutellum *var.* scutellum						X					X		X							
Cymbella affinis *var.* affinis			X	X	X															
Cymbella minuta *var.* silesiaca		X		X	X		F			X					X					X
Cymbella sinuata				X	X					X				X	X					
Cymbella tumida *var.* tumida		X																		
Cymbella turgidula *var.* turgidula					X															X
Diatoma tenue *var.* tenue				P	P								X						X	A
Epithemia adnata *var.* adnata	F	X	X																P	
Epithemia adnata *var.* proboscidea				X							X									X

	CLADOPHORA										RHIZOCLONIUM	OEDOGONIUM				HYDRODICTYON		VAUCHERIA	
	1412	1416	1417	1418	1419	1632	1637	1650	1667	1670	1425	1423	1459	1643	1647	1632	1667	1413	1451
Epithemia sorex *var.* sorex	X		P	X	X					X			X					X	X
Fragilaria *brevistriata* *var.* brevistriata		F	X																
Fragilaria construens *var.* venter		X	X																
Fragilaria pinnata *var.* pinnata		X																	
Fragilaria vaucheriae *var.* vaucheriae		X		X	X		X	X		X				A	X				A
Frustulia vulgaris *var.* vulgaris		X		X										X				X	
Gomphoneis herculeana *var.* robusta		X				X	X	F	X	X					X	X			
Gomphonema acuminatum *var.* acuminatum		X	A				X												
Gomphonema affine *var.* affine		X	X		X				X										
Gomphonema gracile *var.* gracile	X																		
Gomphonema parvulum *var.* parvulum		X	X		X	X	A	X	A				A	F	A	X	X		
Gomphonema subclavatum *var.* subclavatum					X											X			X
Gomphonema subclavatum *var.* commutatum													X						
Gomphonema subclavatum *var.* mexicanum			X			P										A			
Gomphonema tenellum *var.* tenellum					P			P		X			X	X	X				X
Gomphonema truncatum *var.* truncatum	X	X	F		X	X	F		X	X								X	
Hantzschia amphioxys		X																	
Navicula cryptocephala *var.* veneta		X	X	X	F									X				X	
Navicula mutica *var.* mutica									X					X	X				

	CLADOPHORA										RHIZOCLONIUM	OEDOGONIUM				HYDRODICTYON		VAUCHERIA	
	1412	1416	1417	1418	1419	1632	1637	1650	1667	1670	1425	1423	1459	1643	1647	1632	1667	1413	1451
Navicula pupula *var.* pupula									X					X			X		
Navicula salinarum *var.* intermedia				X	X			X						X	X				
Navicula *aff.* tripunctata					X														
Navicula viridula *var.* avenacea		X	X	X	X					X				X	X				X
Nitzschia amphibia		F	X	X	X				F	A	X	X	P				X	X	X
Nitzschia frustulum		A	X		X		X		X	X		X	X		X		X		
Nitzschia *aff.* inconspicua									X										
Nitzschia palea		X			X		X		F	X	X		X	F	A		X	X	X
Rhoicosphenia curvata *var.* curvata														X	X				
Rhopalodia gibba *var.* ventricosa					X														
Rhopalodia musculus *var.* musculus				X	X														
Surirella angusta														X					
Surirella *aff.* ovata				X											F				
Synedra acus *var.* acus			X																
Synedra fasciculata *var.* fasciculata	P	P	F	X	X						X							A	X
Synedra pulchella *var.* pulchella				X															
Synedra rumpens *var.* familiaris					X		X			X					X				
Synedra ulna	X		X			X	P	X	X	X			X		P	X	P	X	

F= frequent A= abundant P= predominant

TABLE N° II. Distribution of taxa in the studied genera.

GENERA	TOTAL TAXA	CLADOPHORA	RHIZOCLONIUM	OEDOGONIUM	HYDRODICTYON	VAUCHERIA
Aehnanthes	5	5	—	3	—	4
Amphora	2	2	1	1	1	1
Ceratoneis	1	1	—	1	—	—
Cocconeis	2	2	1	2	1	1
Cymbella	5	4	—	2	—	2
Diatoma	1	1	—	1	—	1
Epithemia	3	3	1	1	—	3
Fragilaria	4	4	—	1	—	1
Frustulia	1	1	—	1	—	1
Gomphoneis	1	1	—	1	1	—
Gomphonema	9	8	—	3	3	3
Hantzschia	1	1	—	—	—	—
Navicula	6	6	—	5	1	2
Nitzschia	4	4	2	3	3	2
Rhoicosphenia	1	1	—	2	—	—
Rhopalodia	2	2	—	—	—	—
Surirella	2	1	—	2	1	2
Synedra	5	5	1	2	1	2
18	55	52	6	31	12	25